soils occurring where the water table or perched water bodies lie near the surface present a potential for liquefaction.

TA-55 is located just to the southwest of the southern terminus of Rendija Canyon Fault, which is located about 1.3 kilometers (0.8 miles) northwest of the facility. Site stratigraphy is generally expected to be similar to that described above for TA-18, except that the thickness of overlying alluvium is thinner.

4.2.6 Water Resources

4.2.6.1 Surface Water

Surface water in the Los Alamos area occurs primarily as short-lived or intermittent reaches of streams (i.e., arroyos). Perennial springs on the flanks of the Jemez Mountains supply base flow into the upper reaches of some canyons, but the volume is insufficient to maintain surface flows across the LANL site before they are depleted by evaporation, transpiration, and infiltration. Runoff from heavy thunderstorms or heavy snowmelt reaches the Rio Grande, the major river in north-central New Mexico, several times a year in some drainages. Effluent from sanitary sewage, industrial water treatment plants, and cooling-tower blowdown enter some canyons at rates sufficient to maintain surface flows for varying distances. Major watersheds in the LANL region are shown in **Figure 4–5**. All of these watersheds are tributaries to an 18-kilometer (11-mile) segment of the Rio Grande between Otowi Bridge and Frijoles Canyon. The Rio Grande passes through Cochiti Lake, approximately 18 kilometers (11 miles) below Frijoles Canyon. The Los Alamos Reservoir, in upper Los Alamos Canyon, has a capacity of 51,000 cubic meters (41 acre-feet). The reservoir water is used for recreation, swimming, fishing, and landscape irrigation in the Los Alamos town site. The Pajarito Plateau Canyons, which serve as collection points for the regional watersheds, originate either along the eastern rim of the Sierra de Los Valles or on the Pajarito Plateau. Within LANL boundaries, only Los Alamos, Pajarito, Water, Ancho, Sandia, Pueblo, and Chaquehui Canyons contain reaches or streams with sections that have continuous flow. Intermittent streams within LANL property are not classified, but are protected by the State of New Mexico for livestock watering and wildlife habitat use (New Mexico Administrative Code 20.6.4.10). Surface water within LANL boundaries is not a source of municipal, industrial, or irrigation water, but is used by wildlife that live within, or migrate through, the region.

Most of LANL effluent is discharged into normally dry arroyos, and LANL is required to meet effluent limitations under the National Pollutant Discharge Elimination System (NPDES) permit program that requires routine effluents monitoring. Therefore, the water quality of the intermittent streams is more characteristic of the quality of these discharges than of natural runoff, as reflected in the results of 1999 surface water and runoff monitoring. LANL's current NPDES permit (No. NM0028355), which was reissued in December 2000, covers all onsite industrial and sanitary effluent discharges, and DOE and the University California are co-permittees. As a result of an outfall reduction program, the number of outfalls requiring monitoring under the permit was reduced from 36 (including 1 sanitary outfall from the Sanitary Wastewater Systems Facility and 35 industrial wastewater outfalls) to 21 in the recently reissued permit. This reduction was achieved by removing process flows for 7 industrial outfalls and completing the lease transfer of the drinking water system, including 9 associated outfalls, to Los Alamos County. During 1999, permit compliance was determined from analysis of 1,250 industrial outfall samples and 175 samples from the Sanitary Wastewater Systems Facility (Outfall 13S) for such parameters as metals, radionuclides, and convention parameters (e.g., pH, total suspended solids, etc.). Monitoring results are submitted to EPA and to the New Mexico Environment Department. The NPDES permit compliance rate for all discharge points was 98.9 percent, with a total of 16 industrial outfall samples exceeding permit limits (LANL 2000f). Industrial and sanitary effluent management is discussed further in Section 4.2.12.5.

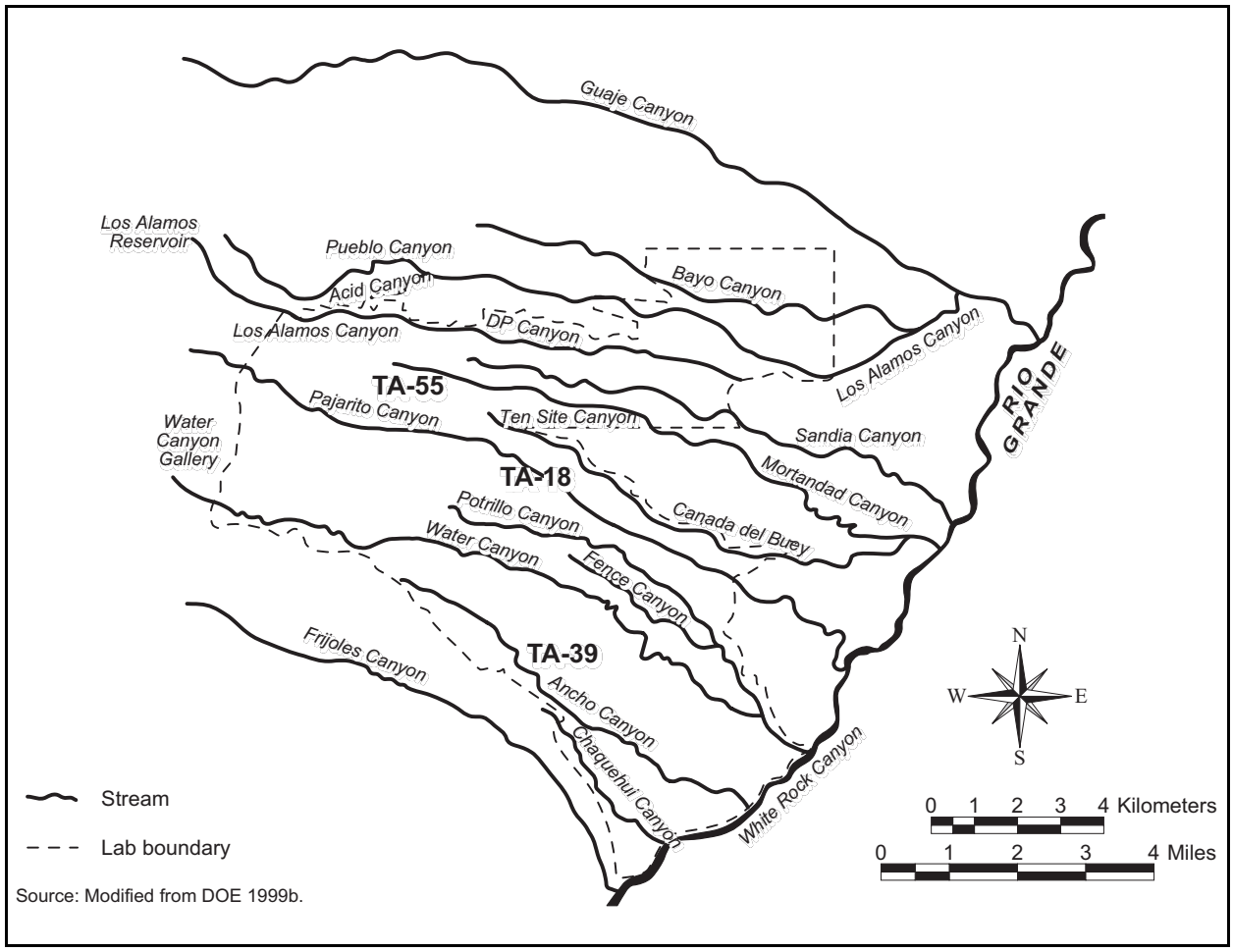

Figure 4–5 Surface Water Features at LANL

LANL also operated under seven NPDES stormwater discharge permits in 1999, including six issued for construction activities and one multisector general permit for stormwater discharges associated with industrial activity for which DOE and the University of California are also co-permittees. As required under this general permit, LANL performed stormwater monitoring in 1999 and developed and implemented 22 storm-water pollution prevention plans for its industrial activities (LANL 2000f).

LANL monitors surface waters from regional and Pajarito Plateau stations to evaluate the environmental effects of facility operations. Historical activities and resulting effluent discharges have affected water courses and associated sediments particularly in Acid, Pueblo, Los Alamos, and Mortandad Canyons and, consequently, continue to affect surface water and runoff quality in these areas (LANL 2000f). Surface water grab samples are collected annually from locations where effluent discharges or natural runoff maintains stream flow. Runoff samples are also collected and, since 1996, they have been collected using stream gaging stations, some with automated samplers. Samples are collected when a significant rainfall event causes flow in a monitored portion of a drainage. Many runoff stations are located where drainages cross the LANL boundaries. Detailed information on surface water and stormwater runoff monitoring including analytical results are contained in the annual site environmental report (LANL 2000f).

Among the environmental effects produced by the Cerro Grande Fire was an increased potential for stormwater runoff through the canyons that cross LANL property as a result of the loss of vegetation and soil organic matter. It is expected that soil erosion rates and corresponding sediments loads in runoff from

denuded watersheds will be much higher than prefire levels for many years resulting in the potential for sediment and debris-laden runoff to reach the Rio Grande. It is also likely that runoff and ambient water quality in canyon drainages will be temporarily reduced by the increase in suspended sediment and by the liberation of organic nitrogen from fire-burned soils, the latter of which can also impact shallow groundwater (DOE 2000h).

DOE has delineated all 100-year floodplains within LANL boundaries, which are generally associated with canyon drainages. There are a number of structures within the 100-year floodplain. Most may be characterized as small storage buildings, guard stations, well heads, water treatment stations, and some light laboratory buildings. There are no waste management facilities in the 100-year floodplain. Some facilities are characterized as "moderate hazard" due to the presence of sealed sources or x-ray equipment, but most are designated "low hazard" or "no hazard". The 500-year floodplain has been designated for Los Alamos Canyon. Overall, most laboratory development is on mesa tops, and development within canyons is light (DOE 2000h). Nevertheless, for practical purposes the Cerro Grande Fire has increased the extent of all delineated floodplains in and below burned watershed areas (i.e., predominantly Los Alamos, Sandia, Mortandad, Pajarito, and Water Canyons) due to vegetation loss. This will allow more stormwater runoff to reach the canyon bottoms and could subject LANL facilities located within or near the prefire delineated floodplain areas to increased erosion or sediment and debris deposition (DOE 2000h).

TA-18 contains no permanent, natural, surface water bodies, and the reach of the Pajarito Canyon near the developed area is not perennial. Portions of the facility complex, including the SHEBA building, are located within the 100-year floodplain associated with Pajarito Canyon. TA-18 is located at the confluence of Pajarito and Three Mile Canyons. These watersheds were among those impacted by the Cerro Grande Fire, which substantially increased the postburn peak runoff flow rate in the canyons. For Pajarito Canyon at TA-18, hydrologic modeling indicates that the peak flow for stormwater runoff from the 6-hour, 100-year storm has increased from a pre-burn rate of 4.13 cubic meters per second (146 cubic feet per second) to an estimated 70.6 cubic meters per second (2,492 cubic feet per second) (DOE 2000h). Nevertheless, DOE has taken steps to ensure that the facility is protected from flooding associated with the postfire 100-year storm. This has included the construction of additional structural controls including a new flood retention structure upstream from the facility, a trash rack to retain flood debris, excavated flow channel, and installation of metal sheet piling to divert floodwaters and to protect individual structures from flood-propelled projectiles (LANL 2000c).

TA-55 contains no permanent, natural surface water bodies and the developed areas are not located within a delineated floodplain.

4.2.6.2 Groundwater

Groundwater in the Los Alamos area occurs as perched groundwater near the surface in shallow canyon bottom alluvium and at deeper levels in the main (regional) aquifer (LANL 2000f). Most aquifers underlying LANL and vicinity, except for perched groundwater bodies, are considered Class II aquifers (i.e., those currently used or potentially available for drinking water or other beneficial use). Alluvial groundwater bodies within LANL boundaries have been primarily characterized by drilling wells on a localized basis where LANL operations are conducted. Wells in Mortandad, Los Alamos, Pueblo, and Pajarito Canyons and in Cañada del Buey indicate the presence of continually saturated alluvial groundwater bodies. Intermediate perched groundwater bodies of limited extent are known to occur within the conglomerates and basalts beneath the alluvium in portions of Pueblo, Los Alamos, and Sandia Canyons; in volcanic rocks on the sides of the Jemez Mountains to the west of LANL, from which it discharges at spring heads; and on the western portion of the Pajarito Plateau (LANL 2000f).

The locations and extent of perched groundwater bodies have not been fully characterized at LANL, but investigations are continuing, and unidentified perched aquifers may exist. The depth to perched groundwater from the surface ranges from approximately 27 meters (90 feet) in the middle of Pueblo Canyon to about 137 meters (450 feet) in lower Sandia Canyon. The regional aquifer exists in the sedimentary and volcanic rocks of the Española Basin, with a lateral extent from the Jemez Mountains in the west to the Sangre de Cristo Mountains in the east (see **Figure 4–6**). The hydrostratigraphic (water-bearing) units comprising the regional aquifer include the interconnected Puye Formation and the Tesuque Formation of the Santa Fe Group, with the top of the aquifer originating in the Cerros del Rio Formation, rather than in the Puye Formation, in some locations. Groundwater flow paths are conceptually illustrated in Figure 4–6. Groundwater flow is generally to the east.

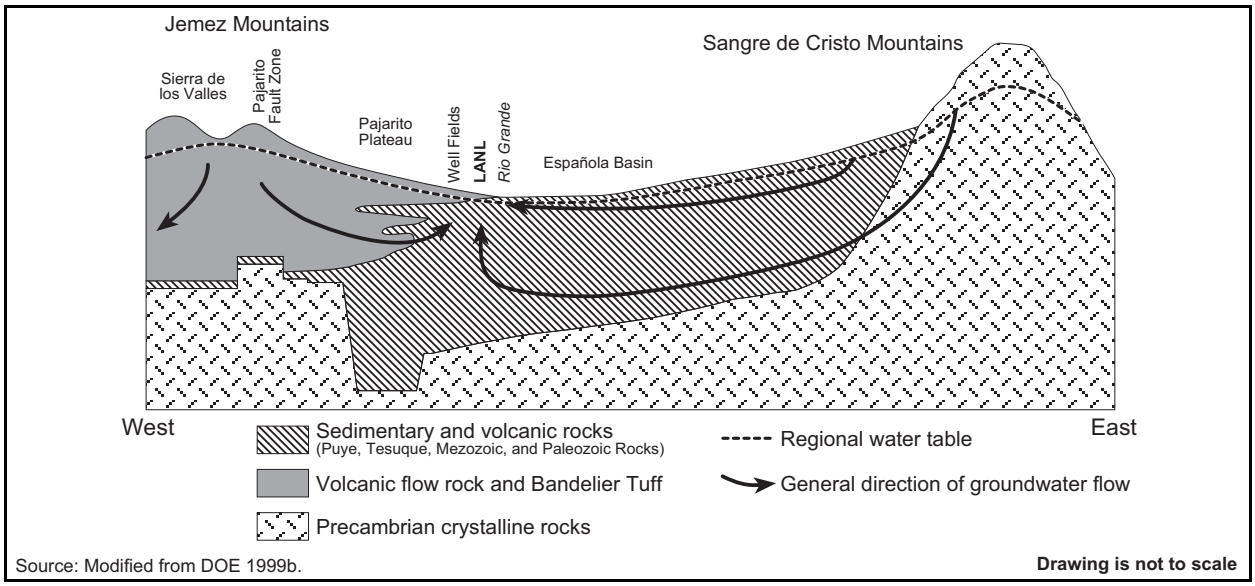

Figure 4–6 Hydrogeology of the Española Portion of the Northern Rio Grande Basin

The regional aquifer is hydraulically separated for practical purposes from the overlying alluvial and intermediate perched groundwater bodies by unsaturated volcanic tuff and sedimentary strata, with the regional water table surface lying at a depth below land surface that varies from approximately 366 meters (1,200 feet) along the western boundary of the Pajarito Plateau to approximately 183 meters (600 feet) along its eastern edge. Thus, these hydrogeologic conditions tend to insulate the regional aquifer from near-surface waste management activities. Water in the regional aquifer is under artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande.

Recharge of the regional aquifer has not been fully characterized and sources are uncertain; data suggest that the regional aquifer of the Española Basin is not strongly interconnected across its extent. Recent investigations further suggest that the majority of water pumped to date has been from storage, with minimal recharge of the regional aquifer. While the regional aquifer is present beneath all watersheds across the LANL region, it is also generally considered to receive negligible recharge from surface water streams in the watersheds. Springs in the LANL area originate from alluvial and intermediate perched groundwater bodies and the regional aquifer and occur in the Guaje, Pueblo, Los Alamos, Pajarito, Frijoles, and White Rock Canyon watersheds. In particular, 27 springs discharge from the regional aquifer into White Rock Canyon. A perched aquifer yields a relatively high flow to a former potable water supply gallery in Water Canyon (LANL 2000f).

Short-term effects of last year's Cerro Grande Fire on LANL groundwater resources include a potential increase in the prevalence of perched groundwater and springs. Also, as discussed for surface water, the liberation of organic nitrogen from burned soils could impact shallow groundwater in the perched and alluvial zones although the effects on deeper groundwater resources are not known (DOE 2000h).

Groundwater monitoring is conducted within and near LANL and encompasses the alluvial zone, intermediate perched groundwater zone, regional aquifer, and springs. However, although largely insulated from effects resulting from surface activities by hydrogeologic conditions, resource management and protection efforts are focused on the regional aquifer, which is the water supply source for the Los Alamos public water supply. The groundwater monitoring network for alluvial groundwater consists of shallow observation wells located in Mortandad, Los Alamos, Pueblo, and Pajarito Canyons and in Cañada del Buey. Perched groundwater is monitored from two test wells and one spring (i.e., the Water Canyon Gallery). The monitoring network for the regional aquifer includes 8 deep test wells completed by the U.S. Geological Survey, 13 deep supply wells that produce water for all of LANL and the surrounding communities, and from numerous springs, including those in White Rock Canyon (LANL 2000f).

As previously indicated, canyon bottom alluvial groundwater in Pueblo, Los Alamos, and Mortandad Canyons receives effluent and has been affected by it. Most notably, Mortandad Canyon groundwater samples during 1999 exceeded or approached the New Mexico groundwater standards for fluoride and nitrate. The nitrate source is nitric acid from plutonium processing at TA-55 that enters the TA-50 waste stream. However, corrective action measures instituted at the Radioactive Liquid Waste Treatment Facility have had a positive impact on nitrogen waste discharges and associated groundwater concentrations. Detailed information on groundwater monitoring, including analytical results, is presented in the annual site environmental report (LANL 2000f).

The main aquifer is the only body of groundwater in the region that is sufficiently saturated and permeable to transmit economic quantities of water to wells for public use. All drinking water for Los Alamos County, LANL, and Bandelier National Monument comes from the main aquifer. Water use is detailed in Section 4.2.2.4.

TA-18 is immediately underlain by alluvial groundwater. The depth to the regional aquifer beneath the site is approximately 261 meters (855 feet) and the flow is expected to be to the southeast (LANL 2001a).

The depth to groundwater beneath TA-55 is approximately 390 meters (1,280 feet) and the flow is expected to be to the east and southeast (LANL 2001a). As discussed above, effluent from TA-55 is conveyed through the TA-50 wastewater treatment facility and then discharged to Mortandad Canyon.

4.2.7 Ecological Resources

4.2.7.1 Terrestrial Resources

LANL lies within the Colorado Plateau Province. Ecosystems within the laboratory site itself are quite diverse, due partly to the 1,525-meter (5,000-foot) elevational gradient from the Rio Grande on the southeastern boundary to the Jemez Mountains, 20 kilometers (12.4 miles) to the west, and to the many canyons with abrupt slope changes that dissect the site. Only a small portion of the total land area at LANL has been developed (DOE 1996g). In fact, only 5 percent of the site is estimated to be unavailable to most wildlife (because of security fencing). The remaining land has been classified into six major vegetation zones, which are defined by the dominant plants present, and occur within specific elevational zones (see **Figure 4–7**). Ponderosa pine forest, pinyon-juniper woodland, and juniper savannah each occur on the site. Mixed conifer forests (including spruce fir and montane grassland), which occur at higher elevations to the

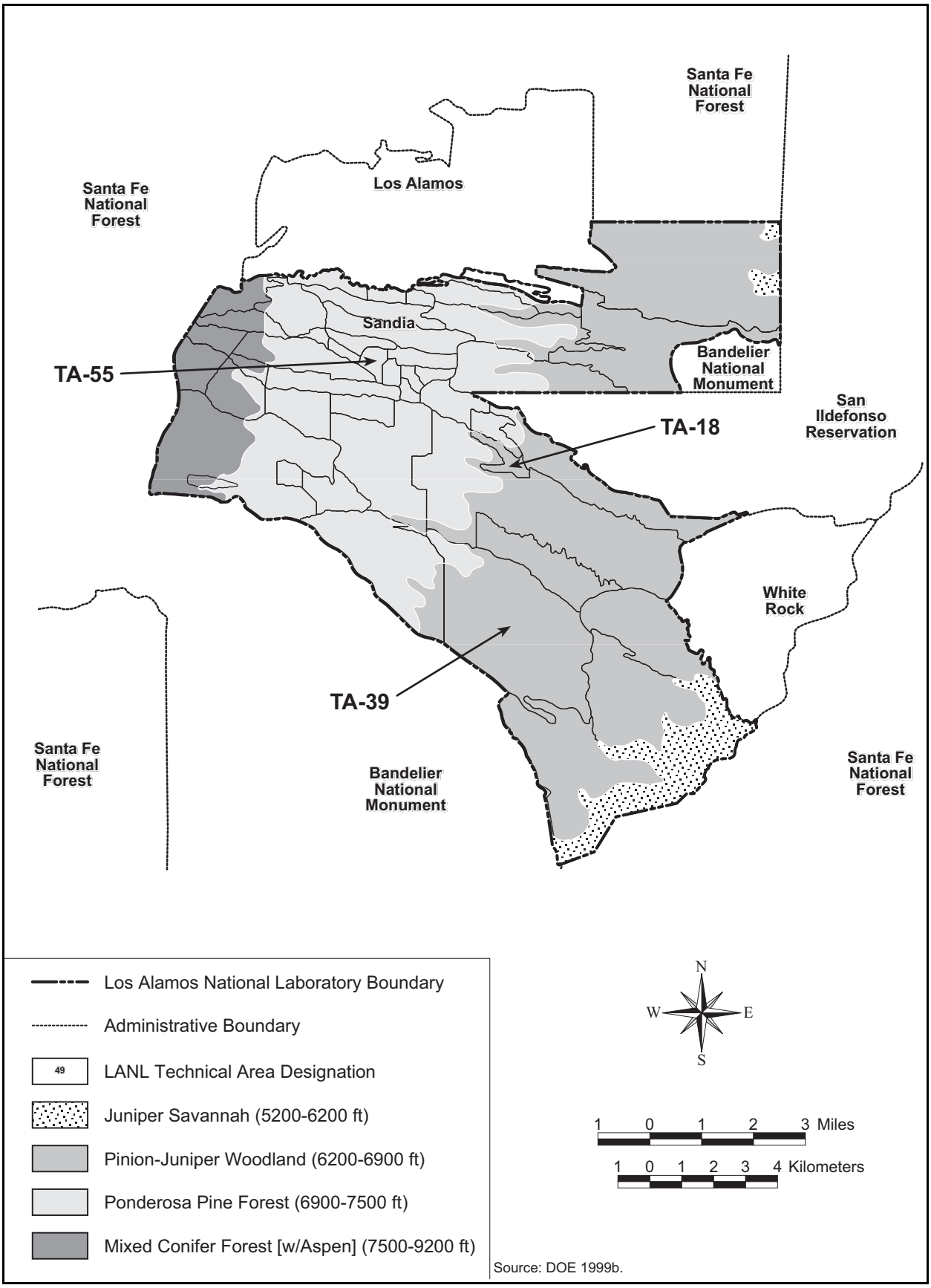

Figure 4–7 LANL Vegetation Zones